AUG Monday Morning Meeting 11/04/2016

Magnetic reconnection measurements with the Imaging Motional Stark Effect diagnostic.

O. P. Ford[1], A. Burckhart[1], V. Igochine[1], M. Yamada[2], A. Bock[1], R. McDermott[1], R. Fischer[1]

1: Max-Planck Institut für Plasmaphysik, Greifswald/Garching, Germany
2: PPPL, Princeton, US

IMSE + Sawteeth: Objective

Measurements of q-profile evolution during sawtooth crash are difficult and so far inconsistent, showing either complete reconnection (q_0 returning to q_0 >= 1.0) or incomplete (q_0 stays below 1.0).

- Attempt to measure q0 changes as directly as possible from the IMSE data.

Pitch Angle

Polarisation $\theta \propto \gamma = \frac{B_z}{B_\phi}$

Large aspect ratio approximation: $q_0 \approx \frac{2B_\phi}{\mu_0 j_0 R}$

$$q_0 \approx \frac{-2B_\phi}{R\left(1+\frac{1}{\kappa^2}\right)\frac{dB_z}{dR}}$$

[CC.Petty Nucl. Fus. 2002]

$$\mu_0 J_\phi \approx -\left(1+\frac{1}{\kappa^2}\right)\frac{dB_z}{dR}$$

Current Density

Elongation

~Derivative of measurement

Calibration: The IMSE still has no reliable absolute calibration for the zero angle profile θ(R, Z). We particularly care about changes in the zero angle profile --> nonzero dθ/dR for jφ = 0.

For the sawtooth experiments, we try two things:

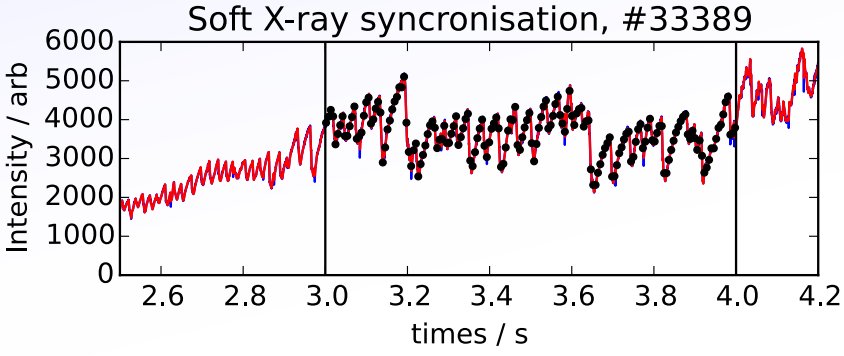
1) ±Bφ shots to find θ_0(R,Z) - shots as close as possible to Sawteeth shots.
(See A. Burckhart's talk)

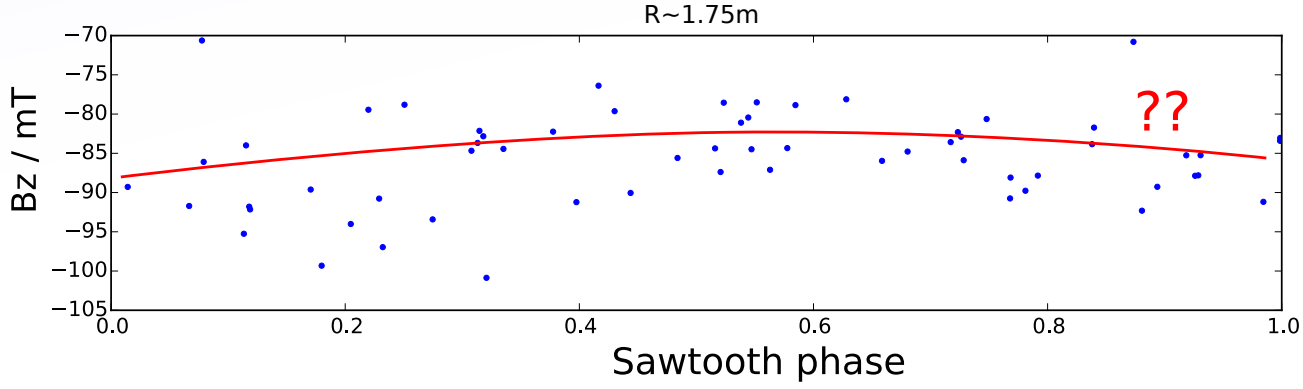
2) Determine q0 by fast particle modes / MHD etc, possibly in a different time period
(V. Igochine)

IMSE + Sawteeth: 33389

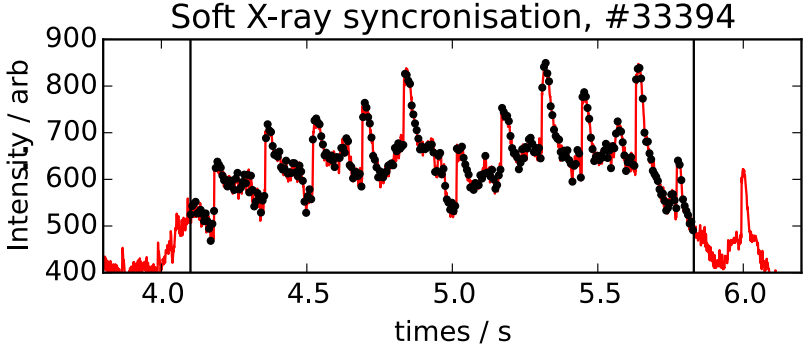
Pitch / Polarisation changes with Sawteeth are VERY small
- Need many identicle large sawteeth to average.

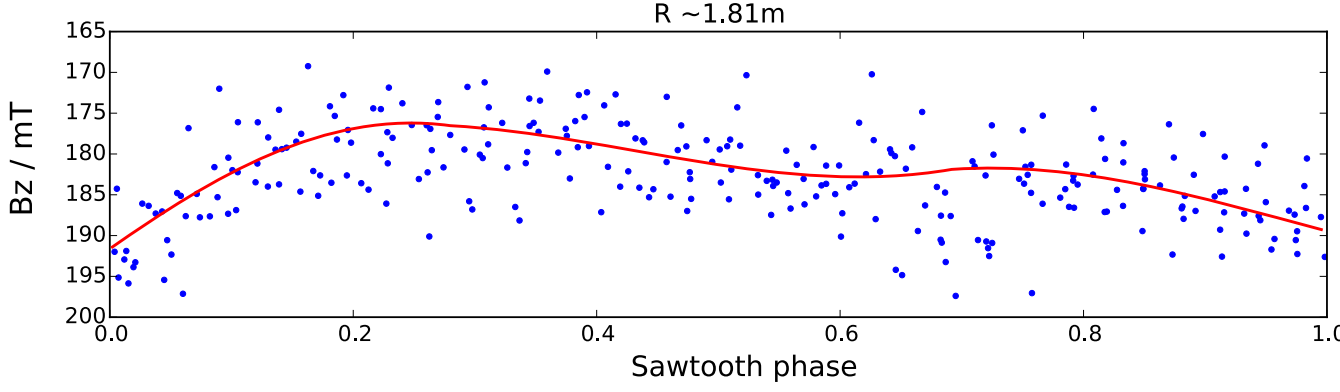
33389 - Some sawtooth but no clean SX or IMSE signatures - difficult to average sawteeth:
No clear sawtooth like behaviour in Bz measurement.





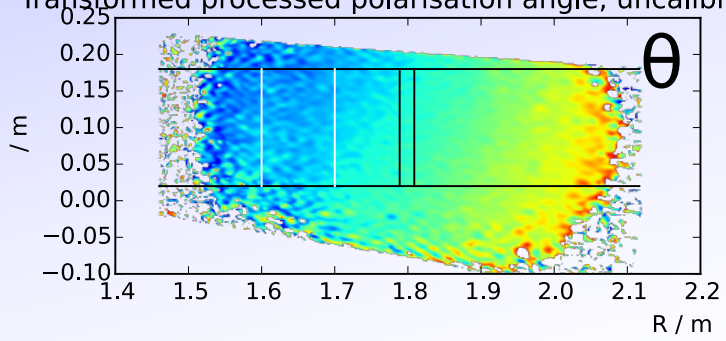
33394 - Clear sawteeth during ICRH period - only 2s, but relatively good IMSE signal.



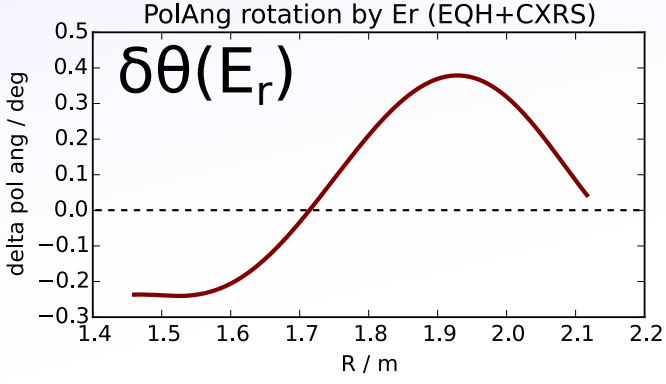


IMSE + Sawteeth: Direct Profiles

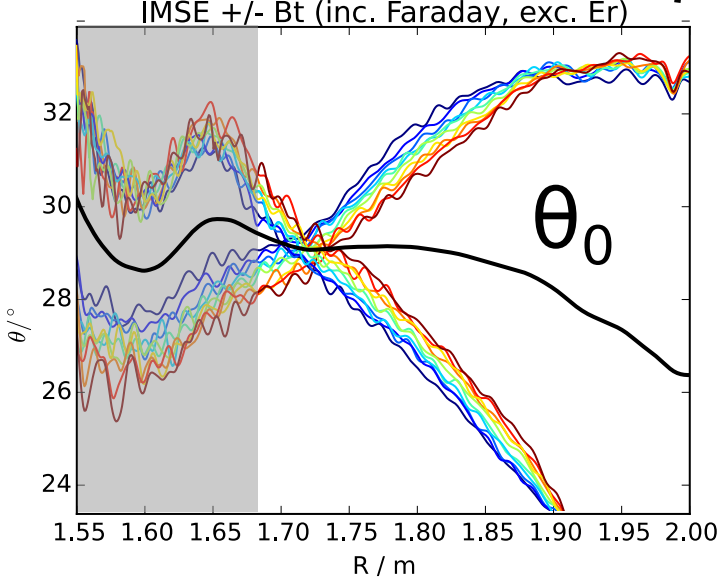
Transformed processed polarisation angle, uncalibrated.



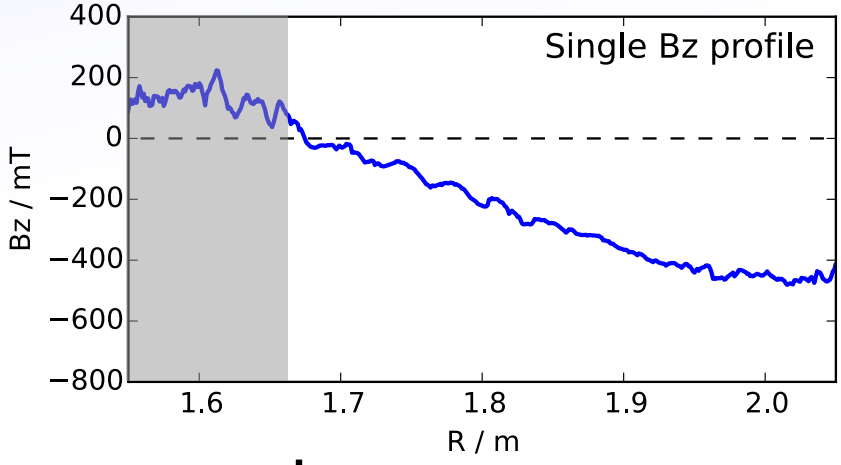
PolAng rotation by Er (EQH+CXRS)



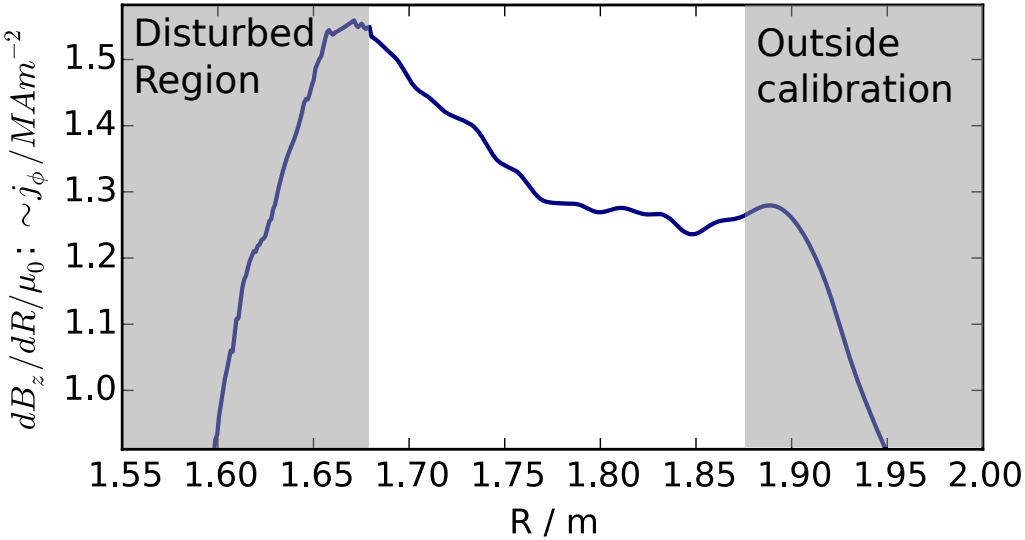
IMSE +/- Bt (inc. Faraday, exc. Er)



From the measured polarisation, we need to subtract the ±Bφ calibration trace and the calculated Er effect and then convert directly to pitch:

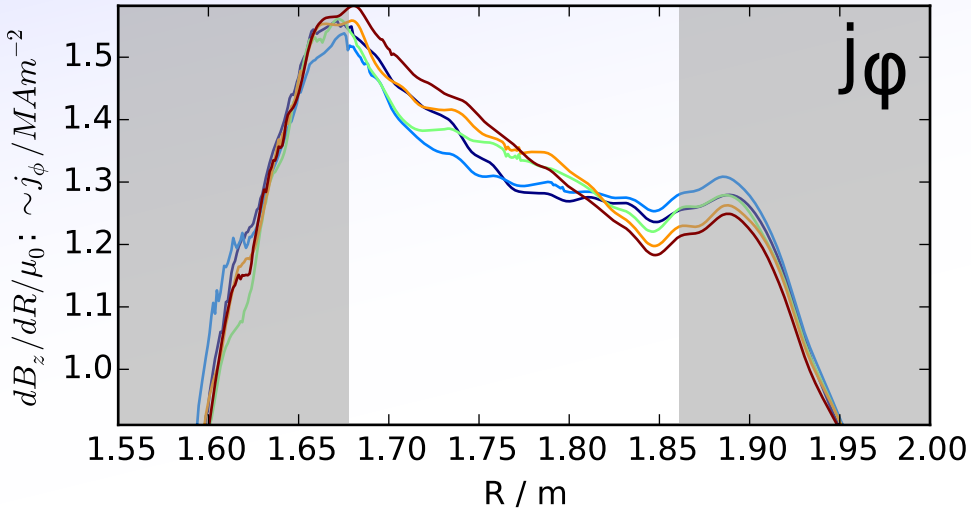


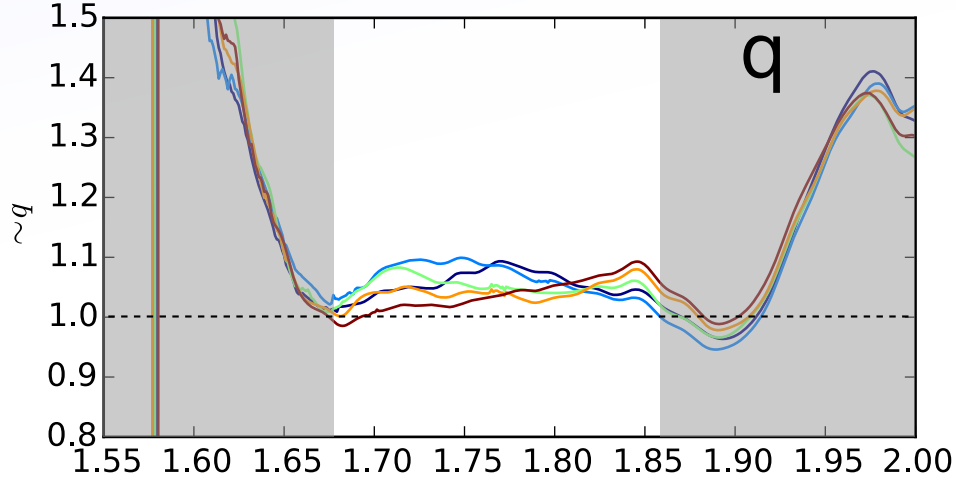
$$\mu_0 J_\phi \approx -\left(1 + \frac{1}{\kappa^2}\right) \frac{dB_z}{dR}$$

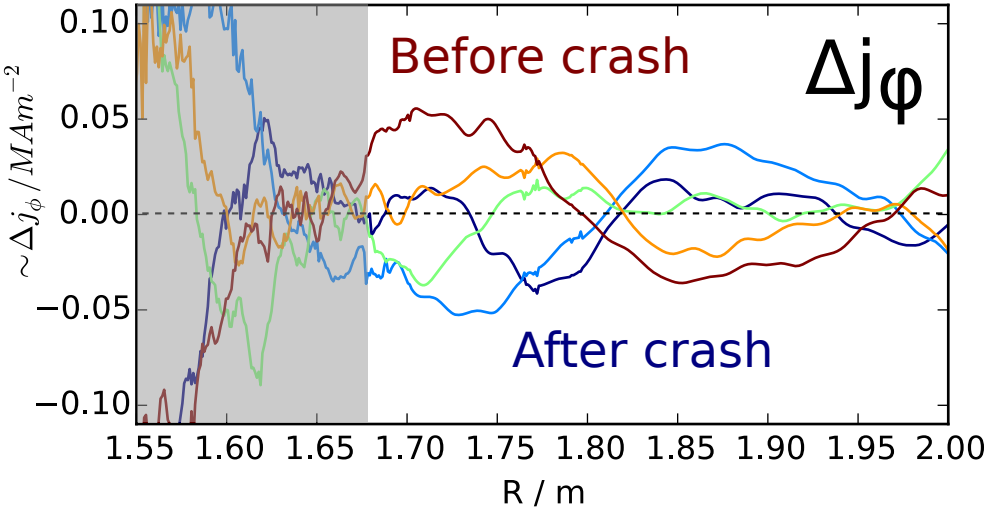


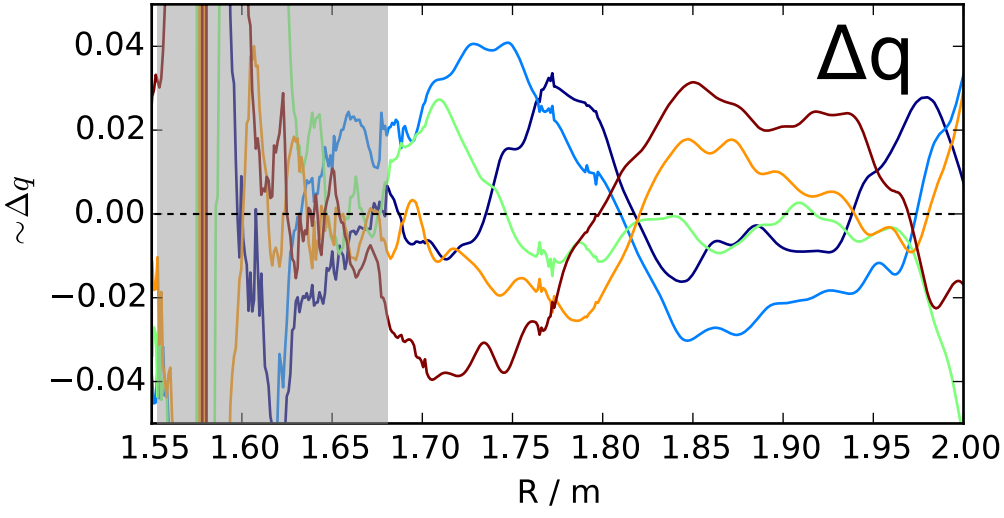
IMSE + Sawteeth: Dynamics

The profile is still not perfect.
The magnitude of the dynamics should be reliable now and the absolute value is close to something sensible (q is around 1.0).









IMSE + Sawteeth: Dynamics

- The final shot (33394) and the calibrations (33391/3) are sufficient to examine the q-profile changes in those sawteeth

- Next step is to look in detail with equilibrium codes.

- More statistics on the sawteeth would give better spatial/phase resolution and more reliable profiles --> run the ICRH for as long as possible.

- To do parameters scans to investigate the reconnection, we need a more reliable sawteeth shot program.

  - Stay with these H-Mode shots (ECRH + ICRH + B-coils) and accept the fishbones etc.
    or
  - Go back to L-mode shots (e.g. 32998, R.McDermott) and try to keep it in L-Mode.